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THE EFFECT OF MILKY DISEASE ON JAPANESE BEETLE POPULATIONS OVER A TEN-YEAR PERIOD

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The milky disease of larvae of the Japanese beetle (Popillia japonica Newm.) is an important factor in the biological control of this insect. This disease is caused by certain soil-inhabiting, spore-forming bacteria, Bacillus popilliae Dutky and B. lentimorbus Dutky, which are exceedingly resistant to temperature and moisture fluctuations. Observations over the large infested area have shown that, when present, the milky disease reduces the beetle population to a low level and prevents substantial increases thereafter. Partly because of the hardiness of these organisms and partly because of the ease with which they may be introduced into new areas, the use of the milky disease has become an important factor in the effort to control the Japanese beetle.

In August 1939 moderate to severe turf injury from Japanese beetle larvae was reported at the Perry Point Veterans Administration Hospital and Facility at Perryville, Md. In a preliminary survey on August 24, 1939, about 37 larvae per square foot were found, 4 percent of them showing gross symptoms of milky disease. They were found to be infected with Bacillus popilliae, the organism responsible for type-A milky disease.

The occurrence of milky disease caused by Bacillus popilliae at the Perry Point Hospital grounds was of extreme interest. Since no treatment with the disease had ever been made at this reservation, the organism either was indigenous or had been introduced by some natural means.

None of the 100 acres of turf on the hospital grounds had received any chemical treatment. The hospital authorities consented to forego contemplated chemical treatment of the soil, and to permit the writers to make regular surveys to follow the natural progress of the disease. These surveys consisted of square-foot diggings at random over the entire turf area. Except for 2 years during World War II, surveys have been conducted each year since 1939.

Table 1.--Observations on abundance of the Japanese beetle in all immature stages and the incidence of the milky disease, Perryville, Md., 1939-1949

Generation	Date	Insects per square foot	Percent milky	Percent reduction in potential emergence
1939-40	Aug. 24	37.0	4.0	
	Sept. 8	38.4	7.2	
	Nov. 8	20.0	10.3	
	June 7	12.0	39.0	
	June 17	6.3	87.0	94.4
1940-41	Aug. 20	14.3	30.3	
	Sept. 4	10.8	28.2	
	Oct. 25	7.3	25.4	
	April 18	5.4	8.1	
	May 29	1.4	27.7	92.8
1941-42	Aug. 12	19.5	23.2	
	Sept. 30	7.6	45.8	
	May 25	3.7	34.9	87.8
1943-44	Aug. 24	13.4	20.8	
1946-47	Aug. 13	12.7	14.5	
	Sept. 12	8.6	33.1	
	Oct. 24	6.8	52.4	
	June 16	4.0	56.0	86.1
1947-48	July 24	17.2	0	
	Aug. 18	11.2	28.4	
	Sept. 3	7.6	30.1	
	Oct. 9	6.5	42.6	
	June 16	2.8	50.0	91.9
1948-49	Aug. 11	9.4	0	
	Sept. 2	7.8	33.3	
	Oct. 21	3.2	20.0	
	June 3	1.3	60.0	94.4

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Table 1 gives in condensed form the records made during this period. In order to indicate properly the fluctuations of the beetle populations, data in this table are presented according to individual broods or generations. For instance, progeny from beetles ovipositing in the soil during the summer of 1939 are referred to as the 1939-40 generation, since the eggs were laid and the grubs hatched in 1939 and the beetles emerged in 1940.

The table does not include data showing the proportion of the immature stages of the Japanese beetle in the soil at the time of the respective surveys, or the extent to which the different stages were infected. Infection was found each year in all three larval instars and to a limited degree during two generations among the prepupal stage. The importance of milky disease in the first and second instars was clearly demonstrated. For example, in the survey on August 20, 1940, when over 56 percent of the population occurred as first-instar larvae, 48 percent of them showed gross symptoms of milky disease. Two weeks later only 22 percent remained in this stage and 87.5 percent were milky.

Infection rates as high as 100 percent in both the first and second instars were shown, depending upon the stage of development at the time the observations were made. Data indicate that as much as two-thirds of the population placed in highly infectious soil may die before reaching the third instar. Very little infection was observed among prepupae and none in the pupal stage.

Microscopical examination of a number of grub cadavers recovered during the course of various surveys showed that the death of the grubs was due to the type-A milky disease. Figures in the table do not tell the entire story of the effect of milky disease, since data obtained at any one survey represent only the conditions present at the time of the survey in question. For instance, although no evidence of disease was observed in the surveys of July 24, 1947, and August 11, 1948, subsequent surveys during both these years showed the effectiveness of milky disease in reducing the soil populations. Surveys to show the disease incidence and mortality must be made at the opportune time; otherwise the small infected larvae will die and disintegrate without being found. When this happens a reduction in population can be demonstrated but the evidence of the agency causing such reduction will be gone.

Each year at the close of the beetle egg-laying period a considerable population exists in the soil. This population drops steadily until early the following summer, when only a small fraction of the original population is able to emerge as beetles. Part of the increase in population shown late in each summer (see table 1) is the result of egg laying by beetles that move in from outside the disease-infected area.

After the disease was well established in this area, there was no appreciable turf damage and chemical treatment was unnecessary in spite of the temporary tendency for re-infestation each summer.

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